

# NIOSH PPT Activities to Support Strategic Goal #2: Reduce Exposure to Dermal Hazards

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PPT Stakeholders' Meeting  
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# NIOSH PPT Strategic Goal #2

## Program Objectives

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- 1. Improve chemical/barrier protective clothing testing and use practices to reduce worker exposure to chemical dermal hazards**
- 2. Improve emergency responder protective clothing to reduce exposure to thermal, biological, and chemical dermal hazards**

# NIOSH PPT Cross Cutting Objectives Applicable to All Strategic Goals

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1. Evaluate the physiological and ergonomic impact of PPE on individual wearers
2. Understand and improve the effectiveness and usability of PPE to reduce the transmission of infectious bioaerosols
3. Evaluate the effectiveness of PPT for protection against nanoparticles
4. Understand and improve the efficacy and effect of decontamination procedures for PPT
5. Develop and foster deployment of technologies that reliably sense or model PPT performance to ensure users receive effective protection
6. Evaluate integration and interoperability of PPT components and the protection provided by composite use of PPT
7. Develop and implement standards to address PPT gaps
8. Gather information on the use and usability of PPT in the workplace to identify research, standards, evaluation, intervention, and outreach needs

# Organization/Staffing/Funding

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- **This strategic goal supported by multiple divisions & locations within NIOSH**
- **NPPTL is the lead division for this strategic goal**
- **Current NIOSH PPT portfolio**
  - Consists of 12+ research projects, including 3 with external funding support
  - Supported by diverse range of scientists, engineers, physiologists, and medical staff
  - Approx. \$900K allocated in FY09

# Development and Validation of PPE Laboratory Preconditioning Techniques for Testing Barrier Materials

**Objective:** Provide standards organizations with validated preconditioning methods so ensembles will be evaluated during certification using more realistic and consistent methods relating to in-service use.

**Background:** Current criteria for barrier material performance are intended to demonstrate protection over the expected service life, but the lack of scientific studies may result in inappropriate tradeoffs that do not balance protection and the stress-related impact of clothing on wearers.

**Status:** Field studies completed with Las Vegas FD, Forth Worth FD, and Fire Department NY. Final report will be delivered to NPPTL in April 09 and provided to NFPA Technical Committees







# Stored Thermal Energy Test Method for Evaluation of Fire Fighter PPE

## Poster

**Background:** Significant numbers of fire fighter burn injuries occur when energy stored within the layers of the protective equipment are suddenly transferred to the skin through compression of the layers and current standards do not adequately evaluate the risk caused by stored energy

Current project activities are part of a multi-organizational project funded by a DHS Fire Grant through the NFPA Fire Protection Research Foundation

NPPTL Role - manage variability studies between test laboratories using the previously developed stored thermal energy test apparatus (funded by NPPTL)

**Status:** Final report was delivered to the NFPA Fire Protection Research Foundation



NIST



Workplace  
Safety and Health

NIOSH

NPPTL Research to Practice  
through Partnerships



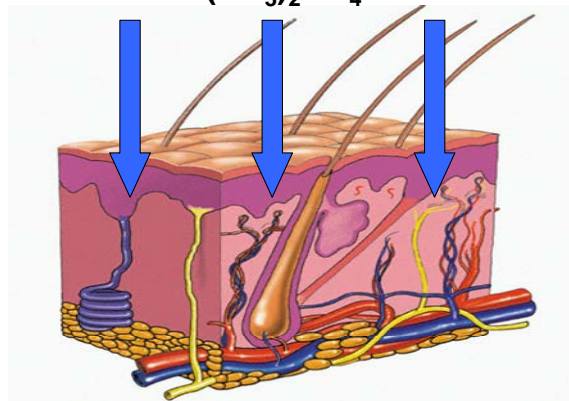
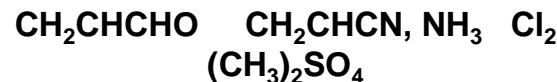
# Risk Based Protective Clothing Materials Permeation Criteria

## Poster

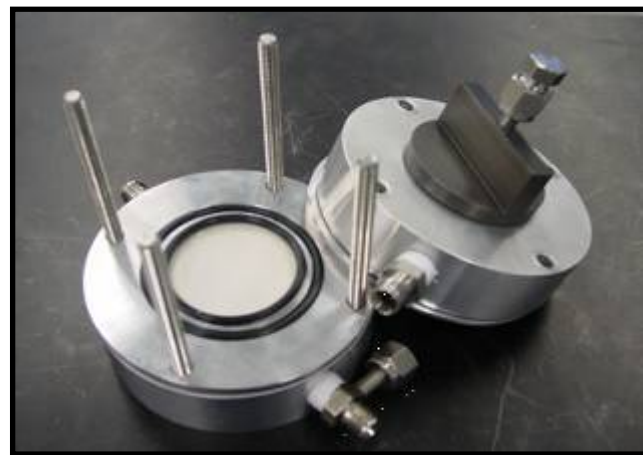
**Objective:** Develop cumulative permeation procedures for the evaluation of protective clothing material barrier performance against toxic industrial chemicals (TICs).

**Background:** Current selection criteria do not account for specific toxicity and skin effects of TICs, which results in ensembles that are over designed and create undue wearer stress.

**Status:** Test set-up has been completed, and testing has begun. Additional work includes adsorbent and detection method selection.



Skin Permeation Model



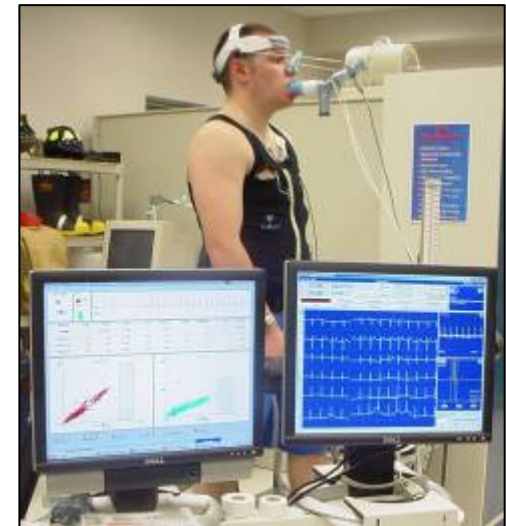
# Development and Validation of Physiological Performance Models to Correlate the Effect of THL

**Objective:** Provide the standards organizations a sound physiological basis for setting THL values in current and future protective clothing performance standards with focus on CBRN standards

**Approach:**

- 3 year project consisting of experiments to be performed on human subjects wearing different types of emergency response protective ensembles (data on skin/core temp, CO<sub>2</sub>/O<sub>2</sub>, etc.)
- Develop and validate physiological performance models that correlate the effect of ensemble materials THL values to responder performance

**Status:** Research protocol under development





# Nanoparticle Penetration Through Protective Clothing

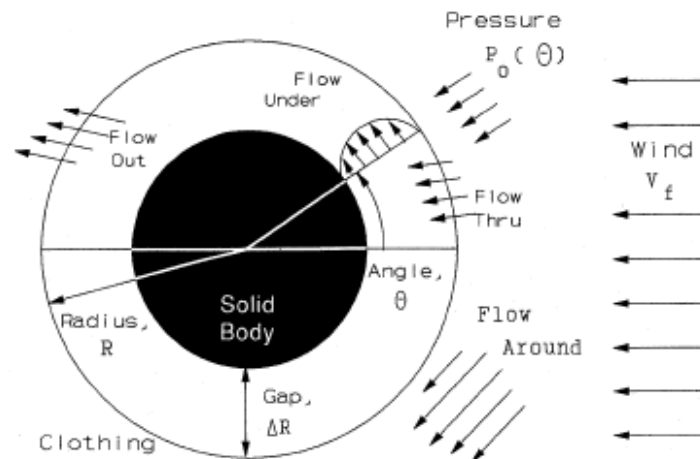
## Poster

**Objective:** Investigate nanoparticle penetration through protective clothing materials due to pressure differences across fabric

### Approach:

- Develop predictive model and conduct research
- The predictive models can be used by government agencies, standards development organizations, and professional organizations to improve and/or develop scientifically appropriate guidance documents, protective clothing performance requirements, and test methods
- Particle penetration data from this study can be used to improve NIOSH guidance on the penetration of nanoparticles through protective clothing and ensembles

**Status:** Research in progress



# Biomechanical and Physiological Study of Firefighter Boots

**Objective:** Determine the effects of boot weight and design on firefighters' biomechanical and physiological response

**Approach:** Firefighters were recruited and tested while performing several simulated firefighting tasks in the laboratory. The study will evaluate the effects of boot weight and material (rubber versus leather) on male and female firefighters' oxygen consumption, joint loading, dynamic balance, and gait characteristics

**Outcome:** Provide scientific data to the NFPA Technical Committee for consideration in the revision to NFPA 1971



Pro Warrington  
Fabric/Leather

Phase 2  
Evaluation



Globe  
Magnum  
Leather

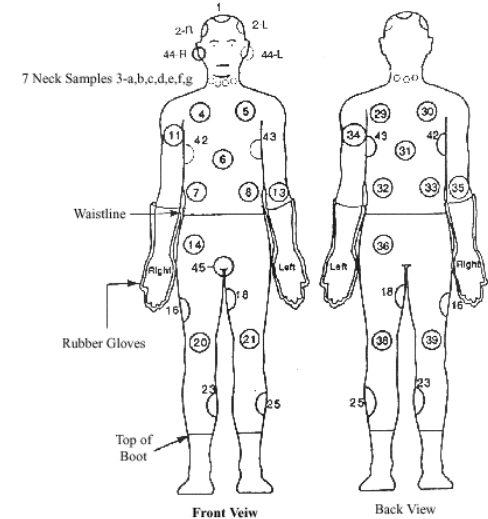
# Development of PPE Ensemble Test Methods

**Goal:** Develop magnetic passive aerosol sampler (MPAS) prototypes that can be used for measuring particle penetration through protective clothing

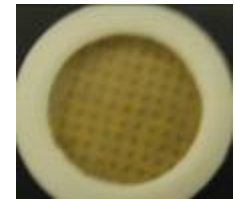
**Background:** Current testing based on active filtration principles, which may overestimate the particle penetration due to additional driving force

**Current status:** MPAS prototypes are promising for man in simulant testing (aerosol-MIST)\*

\* Also supports cross cutting objectives 2, 3 & 7

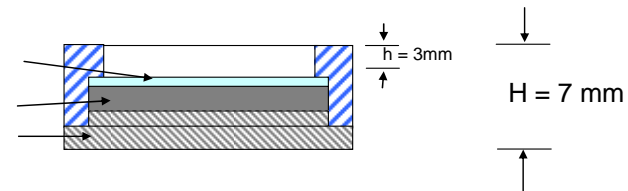


Top View



Magnets underneath the PVC film

PVC Film  
Magnets  
Support



# Improved Criteria for Emergency Medical Protective Clothing

## Poster

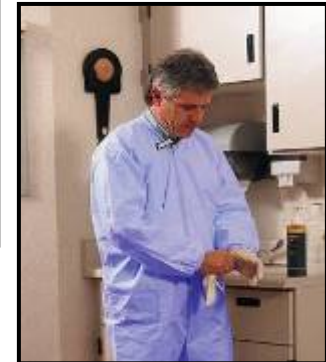
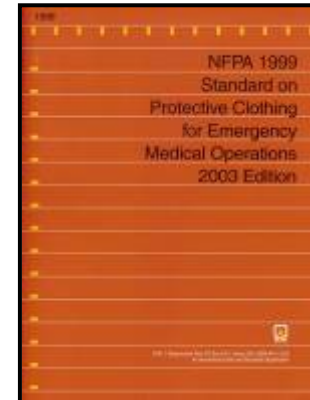
**Goal:** Establish performance criteria for protective clothing and equipment used by emergency medical personnel

**Background:** Mixed industry response to 2003 edition of NFPA 1999 because of conflicting or inappropriate criteria

**Approach:** Obtained end-user input and conducted testing on currently available equipment to determine criteria for revised standard

**Key finding:** Criteria in 2008 edition of NFPA 1999 better match end user expectations and use practices

**Status:** Final report has been delivered. The certification of individual products allows users to select the appropriate level of protection necessary for each response. As of November 20, 2008 there were 26 manufacturers with a total number of 82 products.

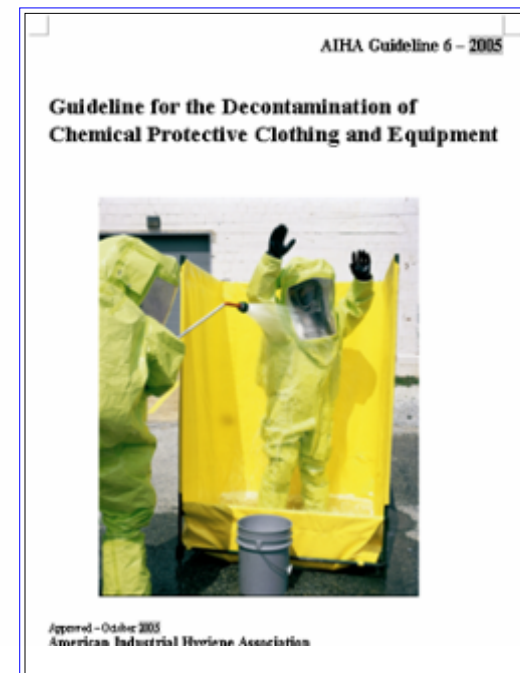


# Degradation and Decontamination Efficacy of Chemical Protective Clothing

## Objectives:

- To develop suitable methods and procedures for decontaminating and extending the useful life of CPC
- To develop test criteria for evaluating decontamination efficacy of CPC
- To provide users with guidelines for reuse, retirement, and disposal of protective clothing.

## Status: Decon Guideline



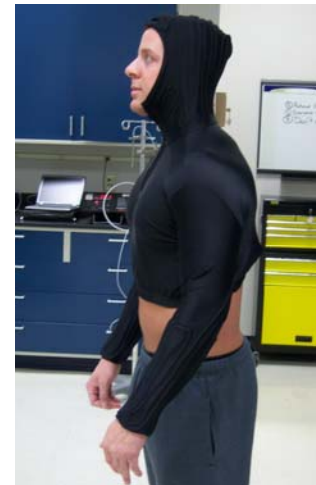


# Physiological Models and Countermeasures

**Objective:** Establish and understanding of the physiological “burden” imposed by personal protective equipment and perform research on countermeasures on this “burden”

**Approach:** Conduct PPE ensemble physiological testing to analyze conductive and convective cooling countermeasures

**Status:** Tested six subjects who completed five cooling sessions and on control session wearing various cooling strategies



# Permeation of Protective Gloves by Chemotherapy Drugs

**Objective:** Conduct extensive permeation testing for gloves used by health care personnel to ensure adequate protection against chemotherapy drugs as required by the new American Society for Testing and Materials Standard D6978-05.

**Approach:** Testing against seven specified drugs and at least two others, which will be chosen via various routes.

**Status:** Fabrication of modified challenge chambers and selection of gloves for testing, and consultation with stakeholders.



# Summary

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- **NIOSH PPT program includes a diverse range of research projects addressing current needs in providing dermal protection to workers**
  - 12+ research projects covering Strategic Goal #2
- **Integration with consensus standards organizations has resulted in the transition of NIOSH research into practice**
  - MOUs with ASTM F23 and NFPA
- **Research portfolio is expanding to address emerging hazards such as dermal exposure to nanomaterials**

# Derma! Hazard Related Posters

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- **Personal Protective Equipment in Workers with Pesticide Illness and First Responders**
- **Decontamination Strategies and Reusability of Chemical Protective Clothing (CDC)**
- **A Multi Domain Magnetic Passive Aerosol Sampler for Measuring Aerosol Particle**
- **Penetration through Personal Protective Ensembles**
- **Nanoparticle Penetration through Protective Clothing**
- **From Nanoparticles to Novel Garments**

# Derma! Hazard Related Posters

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- **Comparison of Physiological Measurements Wearing Firefighter Ensembles: Standard Monitoring Equipment vs. a Wearable Plethysmographic Sensor Vest**
- **Evaluation of Cooling Garments Wearing Prototype Firefighter Ensemble**
- **Improved Emergency Medical Protective Clothing**
- **Risk Based Protective Clothing Material Permeation Criteria**
- **Stored Thermal Energy in Fire Fighter Protective Garments**



# Follow-on Dermal Hazard Presentations

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- **Novel Protective Garments**

**Dr. Shyamala Rajagopalan**  
**Nanoscale Composites**

- **Stored Thermal Energy**

**Angie Shepherd**  
**NPPTL – Technology Research Branch**

# Quality Partnerships Enhance Worker Safety & Health



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***Disclaimer: The findings and conclusions in this presentation have not been formally disseminated by the National Institute for Occupational Safety and Health and should not be construed to represent any agency determination or policy.***

## Thank you